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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/528,262	03/17/2000	Steven P. Den Baars	585-27-009	4221

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EXAMINER
BAUMEISTER, BRADLEY W

ART UNIT	PAPER NUMBER
2815	

DATE MAILED: 11/20/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.	Applicant(s)
09/528,262	Denbaars et al.
Examiner	**Art Unit**
B. William Baumeister	2815

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136 (a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1) ☒ Responsive to communication(s) filed on *Oct 3, 2002*.

2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.

3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11; 453 O.G. 213.

Disposition of Claims

4) ☒ Claim(s) *4-7, 9, 14-16, 24-31, 33-44, and 46-55* is/are pending in the application.

4a) Of the above, claim(s) *48-51* is/are withdrawn from consideration.

5) ☐ Claim(s) _____ is/are allowed.

6) ☒ Claim(s) *4-7, 9, 14-16, 24-31, 33-44, 46, 47, and 52-55* is/are rejected.

7) ☐ Claim(s) _____ is/are objected to.

8) ☐ Claims _____ are subject to restriction and/or election requirement.

Application Papers

9) ☐ The specification is objected to by the Examiner.

10) ☐ The drawing(s) filed on _____ is/are a) ☐ accepted or b) ☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13) ☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a) ☐ All b) ☐ Some* c) ☐ None of:

1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

*See the attached detailed Office action for a list of the certified copies not received.

14) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

a) ☐ The translation of the foreign language provisional application has been received.

15) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s). _____
4) ☐ Interview Summary (PTO-413) Paper No(s). _____
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other:

DETAILED ACTION

Drawings

1. The drawings are objected to because FIG 6 depicts blue and yellow light both being emitted from active layer 67. In fact, the specification teaches that blue light is emitted from active layer 67, and part of the blue light is absorbed into the downconverter 66 and re-emitted as yellow light. A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

Claim Objections

2. Claim 37 is objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form. Independent claim 30 states in part:

> ...said plurality of active layers arranged...such that said substrate absorbs at least some of said light from at least one of said plurality of active layers and re-emits omnidirectional light at a different wavelength.

Depending claim 37 recites that the "LED comprises [either (1)] the light emitting from at least one of said plurality of active layers or [(2)] the light emitting from at least one of said plurality of active layers in combination with the light emitted from said doped substrate."

The second option of claim 37 is substantively of the same scope as claim 30, and the first option is broader than claim 30 in that the first option does not require re-emission of secondary light from the substrate. As such, claim 37 does not further limit, but rather, broadens claim 30.

3. Claim 55 is objected to because of the following informalities: the claim includes the typographical error, "...a respective on [sic: one] of said plurality of p-type layers." Appropriate correction is required.

Claim Rejections - 35 USC § 112

4. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

5. Claims 30-47, 54 and 55 are rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to use the invention. Claim 30 recites that the "plurality of active layers are arranged vertically," and that the LED comprises "a means for selectively causing <u>each</u> of said plurality of active layer to emit omnidirectional light alone or in combination with others of said plurality of active layers." (Underline added) Presumably, this claim is intended to read on the embodiment of FIG 2.

a. At page 10, line 7, the specification asserts that in LED 20,

> ...bias can be applied to one or more of the p-type contacts 27, 28, and 29 which allows the LED 20 to selectively emit different colors of light. For example, with a bias applied to p-type contact 27 and n-type contact 31, holes and electrons are primarily injected into active layer 21 and it emits green light. The light will not be absorbed by the ruby substrate and as a result, the LED 20 only emits green light. Similarly, with a bias applied to p-type contact 28 and n-type contact 31, the LED 20 emits only blue light. With a bias applied to p-type contact 29 and n-type contact 31, active layer 23 emits UV light that the ruby substrate absorbs and re-emits as red light. Thus, by applying a bias to one of the three p-type contacts 27, 28 and 29, the LED 20 can selectively emit green, blue, or red light.

In the stacked-active-layer LEDs disclosed in the specification, carriers (electrons and holes) flow between the n-side contact and the particularly chosen p-side contact causing emission from all intervening active layers. As such, it is generally true that the application of a bias between contacts 29 and 31 will cause the LED to only emit UV light and subsequently re-emit primarily only red light (ignoring any absorption and re-emission from active layers 21 and 22). However, if bias is applied between the n-type contact 31 and either one of p-type contact 27 or 28, carriers will--in fact--flow between the p and n contacts causing light emission either from (a) all three active layers 21-23 (if p-contact 27 is biased) thereby producing green, blue and red (white) light or alternatively (b) from the two active layers 22 and 23 (if p-contact 28 is biased) thereby producing red and blue (purple) light. Thus, while the claims are enabled for producing one color of light (UV => red) when contacts 29 and 31 are biased, the specification does not reasonably provide enablement for selectively causing *each* of the active layers to emit

omnidirectional light alone (only green or blue light). As such, the specification does not enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to the invention commensurate in scope with these claims.

b. Moreover, the specification does not provide any disclosure at all that the embodiment of FIG 6 may have the p-contact 73 biased without the additional biasing of p-contact 72, so this portion of the specification does not provide enablement for single-color operation either.

6. Claims 41-44 are rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. Independent claim 30--previously reciting at least two active layers--has been amended to recite a plurality of active layers that are arranged vertically and means for selectively causing each of said plurality of active layers to emit omnidirectional light alone or in combination with others of said plurality of active layers. (Embodiments which read on these limitations are depicted in Figs 2 and 6, for example.) Claims 41-44 still depend from claim 30 as now amended. These claims recite that the plurality of active layers emit one color of light..." (Claim 41) or that the plurality of active layers emit UV light (claims 42-44). (These claims were previously directed towards the embodiment of FIG 5.) The specification as originally filed does not disclose a plurality of active layers that emit one color of light in combination with the

limitation of means for selectively causing each of said plurality of active layers to emit omnidirectional light alone or in combination with others of said plurality of active layers. This claim now constitutes new matter.

Claim Rejections - 35 USC § 102

7. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

8. Claims 5-7, 14, 16 and 25-28 are rejected under 35 U.S.C. 102(b) as being anticipated by JP '203. JP '203 discloses UV-emitting (250-410 nm), III-N double-heterojunction (e.g., [0003], i.e. single quantum well) LEDs formed on doped substrates such as sapphire that absorb the UV and re-emit various other colors including at least one of red, green or blue (claim 3, emphasis added), and that all three of R, G and B may be used in the same substrate [0021] and to produce a (full) color display (e.g., [0020], [0023]). The invention may further include an optional reflector for directional emission, or alternatively not include the reflector, thereby causing omnidirectional emission. Paragraph [0010] sets forth examples of potential substrate compositions, including sapphire. This paragraph also states that the substrate dopants are selected from various rare earth and transition metal elements, expressly including Cr and Ti. The substrate may be uniformly doped [0010] or alternatively in "a lot of light-emission units" (separate color centers) can be formed on the same substrate [0029]. Also, paragraph [0013]

states that the brightness of red, green and blue pixels (separate color centers) may be individually adjusted and balanced for full-color displays. A Derwent computer translation is included for applicant's reference.

Claim Rejections - 35 USC § 103

9. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

10. Claims 4, 24 and 29 are rejected under 35 U.S.C. 103(a) as being unpatentable over JP '203 as applied to the claims above.

a. Regarding claim 4, the reference states that various conventional UV sources may be employed including LEDs and lasers. The reference further expressly discloses a double heterojunction LED having a single light emission layer (e.g., [0022]) may be employed. Regardless of whether the recitation of a double heterojunction LED is synonymous with a single quantum well (SQW) LED, it was well known to those of ordinary skill in the art at the time of the invention to form GaN-based LEDs so as to have either SQW or MQW active layers, and it would have been obvious to those persons to have employed either depending only upon well-known design considerations such as the trade-offs in manufacturing costs and desired light output, or the specific bandgap desired and the ease of producing the specific bandgap with the particular active layer design.

b. Regarding claims 24 and 29, JP '203 summarily states that the substrate is doped, but does not set forth any specific doping methods. Nonetheless, the claimed doping methods were all conventionally known to those of ordinary skill in the art at the time of the invention and it would have been obvious to those skilled in the art to have employed any one of the listed methods depending only on well known considerations such as the cost or efficiency of employing any particular one of the recited methods.

i. In further regard to claim 24, this claim is, in actually, anticipated by JP '203 according to the well-established product-by-process doctrine because this is a product-by-process claim, and the recited methods of doping do not further distinguish the final structure. However, the claim is alternatively rejected as obvious under 103 in order to render the product-by-process issue moot.

11. Claims 4-7, 9, 14-16, 24-29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kaneko '901 in view of JP '203 as applied to the claims above.

a. Kaneko discloses various III-N LED and LD emitters formed on doped semiconductor substrates for absorption of a primary wavelength in the range of 400-550 nm (UV-yellow) for III-N materials (col. 4, line 23; col. 5, line 7), and re-emission of a second wavelength from the doped substrate which is different/longer than that emitted from the primary LED source. The emitter may emit more than one wavelength (col. 10, lines 11-15). These wavelengths may or may not include the wavelength of the pumping light (the light that pumps

the substrate activator centers) (col. 10, lines 29-36). The semiconductor substrate may be of various materials including sapphire (col. 3, lines 10-15). Various dopants or activators may be employed including Cr, Ti and Co (col. 3, line 15). The substrate may be uniformly or non-uniformly doped and a plurality of dopants can be utilized (col. 3, lines 15-20). Various wavelengths including white light can be selectively generated (col 3, lines 45-50; col. 10, lines 30-36). The invention may be employed for a variety of applications including display devices (col. 3, lines 45-50).

b. Regarding the claims setting forth that the LED emits UV or yellow, Applicant has defined UV as including 400-420 nm (specification, page 5, line 2) and yellow as including 550 nm (specification, page 8, line 4). These wavelengths are disclosed as explained above.

c. Regarding claim 16, Kaneko discloses that the optical crystal substrate may include a plurality of dopants and may be uniformly or non-uniformly doped (col. 3, lines 15-20). Kaneko further teaches that the light source can be configured to emit more than two wavelengths which may or may not include the wavelength of the pumping light, and that these different wavelengths may be used independently (col. 10, lines 30-45).

d. Kaneko does not anticipate the claims because in each of the embodiments mirrors are employed in order to produce directional, coherent emission of the secondary light produced in the substrate, whereas the present claims set forth that the substrate emits light omnidirectionally.

e. As was explained above, JP '203 discloses LEDs formed on doped substrates for the emission of incoherent secondary light from the substrate. When reflectors are not employed, the emission is omnidirectional. The light emitter is employed in display applications. It would have been obvious to one of ordinary skill in the art at the time of the invention to have modified the Kaneko invention by removing the substrate mirrors for the purpose of producing a light emitter that emits incoherent, omnidirectional light instead of coherent, directional light as taught by JP '203 depending only upon the specific lighting application desired, such as those requiring a wider viewing angle than would be afforded by devices emitting coherent, directional light.

12. Claims 9 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over JP '203 as applied to the claims above, and further in view of Kaneko '901 as applied to the claims above. Regarding claim 9, JP teaches UV primary emitters, but does not disclose yellow primary emitters. Regarding claim 15, JP '203 teaches that various rare earth or transition metal elements may be employed as the substrate dopant light emission centers. JP '203 further sets forth specific examples of Cr and Ti, but does not expressly disclose that the particular transition metal, Co, may be employed for the color (R,G,B) display.

a. Kaneko discloses various III-N LED and LD emitters formed on activator-doped semiconductor substrates for absorption of a primary wavelength in the range of 400-550 nm (UV-yellow) for III-N materials (col. 4, line 23; col. 5, line 7), and re-emission of a second wavelength from the doped substrate which is different/longer than that emitted from the primary

LED source. The emitter may emit more than one wavelength (col. 10, lines 11-15). These wavelengths may or may not include the wavelength of the pumping light (the light that pumps the substrate activator centers) (col. 10, lines 29-36). The semiconductor substrate may be of various materials including sapphire (col. 3, lines 10-15). Various dopants or activators may be employed including Cr, Ti and Co (col. 3, line 15). The substrate may be uniformly or non-uniformly doped and a plurality of dopants can be utilized (col. 3, lines 15-20). Various wavelengths including white light can be selectively generated (col 3, lines 45-50; col. 10, lines 30-36).

b. Regarding claim 9, it would have been obvious to one of ordinary skill in the art at the time of the invention to have employed within the JP '203 device, a yellow-emitting InGaN LED as taught by Kaneko, for the purpose of obtaining an orange light, depending only upon the specific emission wavelength desired.

c. Regarding claim 15, it would have been obvious to have particularly employed Co for one of the emission centers in the JP '203 sapphire substrate as taught by Kaneko for any of various reasons such as (1) the specific cost or availability of Co vs other activators specifically recited by JP '203, or (2) the specific emission wavelength and spectral width desired for the particular lighting application.

13. Claims 40-44 52, 53 and 47 are rejected under 35 U.S.C. 103(a) as being unpatentable over JP '203 or alternatively JP '203/Kaneko as applied to the claims above, and further in view of Bojarczuk, Jr. et al. '185.

a. JP '203 teaches that the recombination-center-doped substrate can be employed in a RGB color display (with separate color centers), but does not set forth the conventional details of how the UV-LED is to be biased to effect the independent operation of the separate light centers.

b. Bojarczuk teaches a plurality of blue or UV-LEDs which are arrayed on a common light-emission substrate. See e.g., FIG 8 wherein an LED is formed on a light emission substrate 72 and connected/integrated with circuitry on Si device driver substrate 86. The LED is etched to form trenches that extend downward partially into the n-side layer 74 to isolate the active and p-side layers of the LED. The n-side layer 74 is contacted by a common contact 84/88, and each region of the p-side layer is contacted by separate p-side contacts 82/90. UV light is emitted selectively from the three portions of the LED to be absorbed by secondary B,G,R color-emission centers 94,96,98 formed therebelow. The reference states that the embodiment of FIG 8 is a full-color display (col. 5, lines 31-33); restated, each of the three p-side portions of the LED may be selectively biased independently. Otherwise, a full color display could not be achieved. Bojarczuk does not anticipate the claims because the separated, secondary light re-emission centers of the invention are realized by organic materials patterned on the opposite surface of the light transmission substrate 72 instead of by being formed of substrate dopant regions.

c. It would have been obvious to one of ordinary skill in the art at the time of the invention to have produced a color display with separate RGB substrate-dopant centers as taught by 'JP 203 by employing the LED biasing scheme as taught by Bojarczuk for the purpose of making the three portions of the LED able to be separately biased and thereby be able to produce a full-color display as taught by Bojarczuk.

d. Regarding claims 41-44, the claims are rejected under the interpretation that claim 30 includes unintended language and that Applicant in fact intended that these claims recite plural stacked active layers in an LED that could read on a MQW active structure such as depicted in FIGs 5 wherein each layer of the MQW emits UV, but each active layer is not able to be separately biased. Under this interpretation, Claims 41-44 would also be rendered obvious, because regardless of whether any of the references discloses that the active layer may be composed of a MQW structure it was well known in the art at the time of the invention to have employed MQW structures for active regions of LEDs, and it would have been obvious for those to have done so at least for the purpose of increasing the design freedom in producing an active layer of a desired bandgap (resultant wavelength).

e. Regarding claim 47, Bojarczuk additionally teaches (see FIG 8) a Si common substrate 86 with device drivers (integrated electrical circuitry). It would have been obvious to one of ordinary skill in the art at the time of the invention to have included within the JP '203 device a common substrate with integrated electrical circuitry as taught by Bojarczuk for the purpose of better integrating the device's components.

14. Claims ~~30-40~~ 30,31,33-40, 54 and 55 are rejected under 35 U.S.C. 103(a) as being unpatentable over either JP '203 or alternatively JP '203/Kaneko as applied to the claims above, and further in view of McIntosh '309. As was explained above, JP '203 teaches UV LEDs formed on doped substrates that cause secondary light re-emission. Kaneko discloses the LED can be composed to emit anywhere between UV and yellow. Neither reference teaches LEDs having multiple, stacked layers capable of emitting more than one color of primary light.

a. McIntosh teaches stacked III-N LEDs having two or more quantum-well InGaN active layers that have the respective In concentrations set to emit various combinations such as blue and yellow, respectively, or B,G,R respectively. Various embodiments depict multiple contacts for selective bias of one, some, or all of the active layers to emit any desired combination of the colors. The barrier layers interposing the active layers may be p-doped (e.g., col. 3, lines 1-6). McIntosh does not teach the use of a doped substrate for secondary re-emission.

b. It would have been obvious to one of ordinary skill in the art at the time of the invention to have to have combined the teachings of JP '203 or JP '203/Kaneko with those of McIntosh so as to provide a multi-color LED that emits some of the desired light wavelengths formed on a doped substrate that can emit other ones of the desired wavelengths for the purpose of simultaneously enabling independent color control for a full color display; reducing the lateral space requirements by not requiring separate side-by-side substrate-dopant color centers; and simplifying the manufacturing process and associated cost of growing three InGaN active layers and selectively etching the layers for making appropriate electrical contacts.

i. Further, it would have been specifically obvious to have employed an LED that emits UV, B and G on a ruby (Cr:Al203) substrate because AlN and GaN have relatively close lattice constants while InN has a lattice constant that is not close to AlGaN. Restated, the formation of LEDs having active layers that include small amounts of In (for producing UV to green LEDs) is a relatively mature technology, but forming large In-content InGaN LEDs (for red emission) have historically presented significant problems including (1) lattice-mismatch, (2) In clustering or pooling, and (3) dissimilar requisite (lower) growth temperatures than AlGaN formation; the technology addressing these problems is not as mature. Thus, it would have been obvious to have specifically employed an LED emitting UV, B and G on a red emitting substrate for the purpose of avoiding the problems associated with growing large In content InGaN active layers.

ii. Regarding claim 40, it was known to produce white light from the two complementary colors of blue and yellow. Nichia Co. has been doing this since the mid 1990s. (See applicant's admission in the Background of the Invention, page 2). Also, McIntosh discloses using two or more layers to produce desired colors including white (e.g., FIG 5 and cols. 5 and 6). Also as was explained previously, Kaneko teaches that UV to yellow LEDs can cause secondary re-emission of red light from doped substrates. It would have been obvious to employ a blue/yellow on a red re-emitting substrate for the purpose of obtaining pink light or a white light that has a warmer hue.

15. Claim are rejected under 35 U.S.C. 103(a) as being unpatentable over either JP '203/McIntosh or alternatively JP '203/Kaneko/McIntosh as applied to claims 30-40, 54 and 55 above, and further in view of Applicant's prior art admissions. As was explained above and in the previous Office Action, employing yellow down-converting phosphors was known, as was acknowledged by Applicant. It would have been obvious to one of ordinary skill in the art at the time of the invention to have employed any combination of LED active layers, down-converting phosphor-doped encapsulants and/or substrate dopants, the specific combination chosen depending only upon conventional considerations such as the respective manufacturing limitations and costs and the resultant lifetime associated with each option.

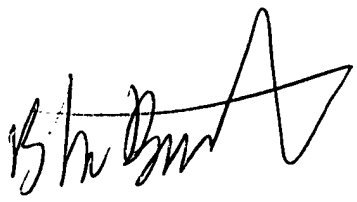
Response to Arguments

16. Applicant's arguments with respect to claims--**including those arguments outlined in response to the examiner's first office action**--have been considered but are either moot in view of the new ground(s) of rejection or are not persuasive for the reasons set forth above.

a. For example, Applicant has argued that JP '203 teaches the emission of red, green **or** blue, but not the emission of red, green **and** blue. This is not persuasive for the reasons set forth above.

INFORMATION ON HOW TO CONTACT THE USPTO

17. Any inquiry concerning this communication or earlier communications from the examiner should be directed to the examiner, **B. William Baumeister,** at **(703) 306-9165.** The examiner can normally be reached Monday through Friday, 8:30 a.m. to 5:00 p.m. If the Examiner is not available, the Examiner's supervisor, Mr. Eddie Lee, can be reached at (703) 308-1690. Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-0956.



B. William Baumeister

November 18, 2002